TYPES OF CHEMICAL BONDS

Name _____

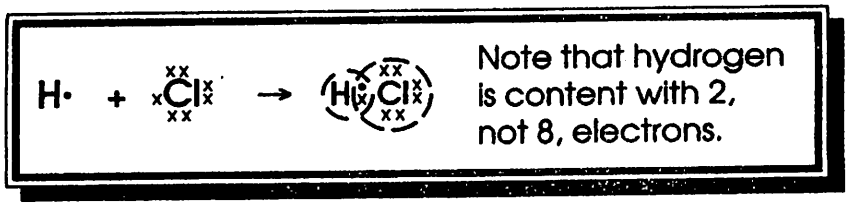
Classify the following compounds as ionic (metal + nonmetal), covalent (nonmetal + nonmetal) or both (compound containing a polyatomic ion).

1. $CaCl_2$ _____
2. CO_2 _____
3. H_2O _____
4. $BaSO_4$ _____
5. K_2O _____
6. NaF _____
7. Na_2CO_3 _____
8. CH_4 _____
9. SO_3 _____
10. LiBr _____
11. MgO _____
12. NH_4Cl _____
13. HCl _____
14. KI _____
15. NaOH _____
16. NO_2 _____
17. $AlPO_4$ _____
18. $FeCl_3$ _____
19. P_2O_5 _____
20. N_2O_3 _____

COVALENT BONDING

Name _____

Covalent bonding occurs when two or more nonmetals share electrons, attempting to attain a stable octet of electrons at least part of the time. For example:



Show how covalent bonding occurs in each of the following pairs of atoms. Atoms may share one, two or three pairs of electrons.

1. H + H (H_2)

2. F + F (F_2)

3. O + O (O_2)

4. N + N (N_2)

5. C + O (CO_2)

6. H + O (H_2O)

Lewis Structures Practice Worksheet

Draw the Lewis structures for the following compounds:

1) PBr_3

2) N_2H_2

3) CH_3OH

4) NO_2^{-1}

5) C_2H_4

Lewis Structures

Draw Lewis Structures of the following molecules

O^{2-}
I_2
H_3O^+
NH_4^+
C_2H_6
C_2H_4
C_2H_2
SiF_4

HCl
HCN
CH_2Cl_2
HNO_2
SO_2 (resonance)
$C_2H_4O_2$
CH_3CH_2NCHOH

Name _____ Class_____ Date_____

13. CHI_3

14. CH_3OH

15. H_2Te

16. OF_2

17. H_2S

18. PCl_3

19. SiO_2

20. CO_2

21. $HClO_4$

22. N_2

23. H_2SO_4

24. NH_3

25. HCN

26. HClO

27. C_2H_4

28. C_2H_2

9. CH_4

10. H_2

11. PH_3

12. Cl_2

29. $HClO_3$

30. ClO_3^-

31. ClO_2^-

32. ClO^-

33. NH_3

34. NH_4^+

35. NH_2^-

36. HNO_3

37. NO_3^-

38. HNO_2

39. NO_2^-

40. H_2O

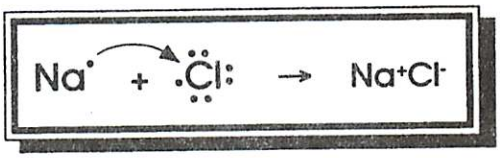
41. H_3O^+

42. OH^-

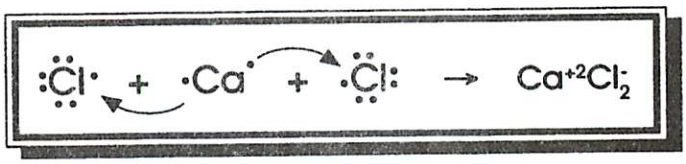
IONIC BONDING

Name _____

Ionic bonding occurs when a metal transfers one or more electrons to a nonmetal in an effort to attain a stable octet of electrons. For example, the transfer of an electron from sodium to chlorine can be depicted by a Lewis dot diagram.



Calcium would need two chlorine atoms to get rid of its two valence electrons.



Show the transfer of electrons in the following combinations.

1. K + F

2. Mg + I

3. Be + S

4. Na + O

5. Al + Br

SHAPES OF MOLECULES

Name _____

Using VSEPR Theory, name and sketch the shape of the following molecules.

1. N_2	7. HF
2. H_2O	8. CH_3OH
3. CO_2	9. H_2S
4. NH_3	10. I_2
5. CH_4	11. $CHCl_3$
6. SO_3	12. O_2

Name _____ Class _____ Date _____

Introduction to Chemical Bonding

Section Review 6.1

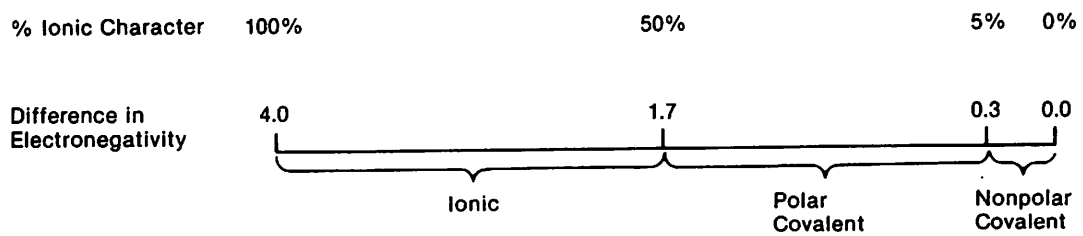
DIRECTIONS: Write on the line at the right of each statement the letter preceding the word or expression that best completes the statement.

1. In a chemical bond, the link between atoms results from the attraction between electrons and (a) Lewis structures; (b) nuclei; (c) van der Waals forces; (d) isotopes. _____ 1
2. A covalent bond consists of (a) a shared electron; (b) a shared electron pair; (c) two electrovalent ions; (d) an octet of electrons. _____ 2
3. If two covalently bonded atoms are identical, the bond is identified as (a) nonpolar covalent; (b) polar covalent; (c) nonionic; (d) coordinate covalent. _____ 3
4. A covalent bond in which there is an unequal attraction for the shared electrons is (a) nonpolar; (b) polar; (c) ionic; (d) dipolar. _____ 4
5. Atoms with a strong attraction for electrons they share with another atom exhibit (a) zero electronegativity; (b) low electronegativity; (c) high electronegativity; (d) Lewis electronegativity. _____ 5
6. Bonds with between 5% and 50% ionic character are considered to be (a) ionic; (b) pure covalent; (c) polar covalent; (d) nonpolar covalent. _____ 6
7. A nonpolar covalent bond is likely to exist between (a) a metal and a nonmetal; (b) two ions; (c) two identical atoms; (d) an atom and an ion. _____ 7
8. The greater the electronegativity difference between two bonded atoms, the greater the percentage of (a) ionic character; (b) covalent character; (c) metallic character; (d) electron sharing. _____ 8
9. In which of these compounds is the bond between the atoms NOT a nonpolar covalent bond? (a) Cl_2 (b) H_2 (c) HCl (d) O_2 _____ 9

DIRECTIONS: Complete the following statements, forming accurate sentences.

10. The electrons involved in the formation of a chemical bond are called _____. 10
11. A chemical bond resulting from electrostatic attraction between positive and negative ions is called a(n) _____. 11
12. If the electrons involved in bonding spend most of the time close to one atom rather than the other, the bond is _____. 12

DIRECTIONS: Questions 13 and 14 refer to the following graph.



13. The difference in electronegativity and the type of bond for the Li–Cl bond in LiCl (electronegativity for Li = 1.0; electronegativity for Cl = 3.0) is _____. 13
14. The difference in electronegativity and the type of bond for the Br–Br bond in Br_2 (electronegativity for Br = 2.8) is _____. 14

Covalent Bonding and Molecular Compounds

DIRECTIONS: Write on the line at the right of each statement the letter preceding the word or expression that best completes the statement.

1. Of the following reactions, the exothermic reaction is
   (a) 1 mole $H_2 \rightarrow$ 2 moles H;
   (b) 1 mole $Cl_2 \rightarrow$ 2 moles Cl;
   (c) 1 mole H + 1 mole Cl $\rightarrow$ 1 mole HCl;
   (d) 1 mole HCl $\rightarrow$ 1 mole H + 1 mole Cl. _____ 1
2. When an atom of one element combines chemically with an atom of another element, both atoms usually attain the stable highest-energy-level configuration of a (a) metal; (b) nonmetal; (c) noble gas; (d) metalloid. _____ 2
3. In a molecule of fluorine, the two shared electrons give each fluorine atom _____ electrons in the outer energy level. (a) 1 (b) 2 (c) 8 (d) 32 _____ 3
4. In writing a Lewis structure, each nonmetal atom except hydrogen should be surrounded by (a) 2 electrons; (b) 4 electrons; (c) 8 electrons; (d) 10 electrons. _____ 4
5. In writing a Lewis structure, the central atom is the (a) atom with the greatest mass; (b) atom with the highest atomic number; (c) atom with the fewest electrons; (d) least electronegative atom. _____ 5
6. To draw the electron-dot symbols for each atom in a Lewis structure, one must know the (a) number of valence electrons in each atom; (b) atomic mass of each atom; (c) bond length of each atom; (d) electronegativity of each atom. _____ 6
7. In the Lewis structure for the ammonium ion, there are ____ valence electrons. (a) 2 (b) 4 (c) 8 (d) 12 _____ 7
8. If, after drawing a Lewis structure, too many valence electrons have been used, the molecule probably contains (a) too many atoms; (b) one or more multiple covalent bonds; (c) too many lone electron pairs; (d) an ionic bond. _____ 8
9. The substance whose Lewis structure indicates three covalent bonds is (a) H_2O; (b) CH_2Cl_2; (c) NH_3; (d) CCl_4. _____ 9
10. How many double bonds are in the Lewis structure for hydrogen fluoride, which contains one hydrogen atom and one fluorine atom? (a) none (b) one (c) two (d) three _____ 10
11. The phosphate ion, PO_4^{3-}, contains how many extra electrons in its Lewis structure? (a) 0 (b) 2 (c) 3 (d) 4 _____ 11

Ionic Bonding and Ionic Compounds

1. In the formula for sodium chloride, NaCl stands for one (a) formula unit; (b) molecule; (c) crystal; (d) atom. _____ 1
2. The chemical formula for an ionic compound represents the (a) number of atoms in each molecule; (b) number of ions in each molecule; (c) simplest ratio of the combined ions that gives neutrality; (d) total number of ions in the crystal lattice. _____ 2
3. A formula that shows the types and numbers of atoms combined in a single molecule is called a(n) (a) molecular formula; (b) ionic formula; (c) Lewis structure; (d) covalent formula. _____ 3
4. In a crystal of an ionic compound, each cation is surrounded by a number of (a) molecules; (b) positive ions; (c) dipoles; (d) anions. _____ 4
5. In a crystal, the valence electrons of adjacent ions (a) repel each other; (b) attract each other; (c) neutralize each other; (d) have no effects on each other. _____ 5
6. Compared to the neutral atoms involved in its formation, the crystal lattice that results is (a) higher in potential energy; (b) lower in potential energy; (c) equal in potential energy; (d) unstable. _____ 6
7. The lattice energy of compound A is greater than that of compound B. What can be deduced from this fact? (a) Compound A is not an ionic compound. (b) It will be more difficult to break the bonds in compound A than in compound B. (c) Compound B is probably a gas. (d) Compound A has larger crystals than compound B. _____ 7
8. Which of the following is NOT a property of an ionic compound? (a) vaporizes readily at room temperature (b) brittle (c) hard (d) electrical conductor in the molten state _____ 8
9. Compared to ionic compounds, molecular compounds (a) have higher boiling points; (b) are brittle; (c) have lower melting points; (d) are harder. _____ 9
10. The forces of attraction between molecules in a molecular compound are (a) stronger than the forces of ionic bonding; (b) weaker than the forces of ionic bonding; (c) approximately equal to the forces of ionic bonding; (d) zero. _____ 10
11. At room temperature, most ionic compounds will be (a) solids; (b) liquids; (c) gases; (d) molten. _____ 11

DIRECTIONS: Complete the following statements, forming accurate sentences.

12. According to the equation 1 mol H_2O + 928 kJ $\rightarrow$ 2 mol H + 1 mol O, the O–H bond energy is _____. 12
13. In the formation of a covalent bond, as the distance between two atoms begins to decrease, the potential energy _____. 13
14. When sodium (electron configuration $1s^2 2s^2 2p^6 3s^1$) combines with chlorine to form sodium chloride, the sodium attains the electron configuration _____. 14
15. The bonds within polyatomic ions are predominantly _____. 15

Metallic Bonding

DIRECTIONS: Write on the line at the right of each statement the letter preceding the word or expression that best completes the statement.

1. Compared to nonmetals, the number of valence electrons in metals tends to be (a) smaller; (b) greater; (c) about the same; (d) almost triple that of nonmetals. _____ 1
2. In metals, the valence electrons are considered to be (a) attached to particular positive ions; (b) shared by all of the atoms; (c) immobile; (d) involved in covalent bonds. _____ 2
3. In *s*-block and *d*-block metals, the number of valence electrons in the outermost *s* sublevel is usually (a) 1 or 2; (b) 2 or 3; (c) 4; (d) 8. _____ 3
4. The fact that metals are malleable and ionic crystals are brittle is best explained in terms of their (a) chemical bonds; (b) London forces; (c) heats of vaporization; (d) polarity. _____ 4
5. The property of metallic luster is most closely related to the metal's (a) electron sea; (b) covalent bonds; (c) brittle crystalline structure; (d) positive ions. _____ 5
6. As light strikes the surface of a metal, the electrons in the electron sea (a) allow the light to pass through; (b) become attached to particular positive ions; (c) fall to lower energy levels; (d) absorb and re-emit the light. _____ 6

DIRECTIONS: Write on the line at the right of each statement the word or expression that best completes the meaning when substituted for the corresponding number.

7. A __(7)__ bond is a type of chemical bond that results from the attraction between positive ions and surrounding mobile electrons. _____ 7
8. The property called __(8)__ is the ability to be shaped or extended by physical pressure. _____ 8
9. __(9)__ is the property of being able to be drawn into a wire. _____ 9
10. Metals are referred to as __(10)__, which means shiny. _____ 10

The Properties of Molecular Compounds

DIRECTIONS: Write on the line at the right of each statement the letter preceding the word or expression that best completes the statement.

1. VSEPR is based on the assumption that (a) electrons in molecules repel each other; (b) positive ions attract negative ions; (c) positive ions in a crystal repel each other; (d) sp^3 hybridization occurs in metallic bonding. _____ 1
2. The structure of the methane molecule (CH_4) is described as (a) square; (b) pyramidal; (c) pentagonal; (d) tetrahedral. _____ 2
3. A molecule of ammonia is classified in VSEPR theory as AB_3E, where the E stands for a(n) (a) crystal lattice; (b) dipole; (c) hybrid orbital; (d) unshared electron pair. _____ 3
4. In molecules, unshared electron pairs tend to (a) attract valence electrons; (b) repel electrons more strongly than bonding electron-pairs; (c) repel the nucleus; (d) attract other unshared electron pairs. _____ 4
5. In orbital notation, the hybridized orbitals responsible for the bent shape of the water molecule are identified as (a) $1s^2 2s^2$; (b) ps^1; (c) sp^3; (d) $2s^2 sp^2$. _____ 5
6. Hybridization helps to explain molecular bonding in situations in which the valence electrons in the uncombined atom (a) number more than 8; (b) are in orbitals with different shapes; (c) number less than 3; (d) are not available for bond formation. _____ 6
7. Dipole-dipole forces are considered the most important forces in polar substances because the London dispersion forces (a) exist only in nonpolar substances; (b) are usually much weaker than the dipole-dipole forces; (c) are too unpredictable; (d) occur only in solids. _____ 7
8. The equal but opposite charges present in two regions of a polar molecule create a(n) (a) electron sea; (b) dipole; (c) crystal lattice; (d) ionic bond. _____ 8
9. Of the following molecules, all of which contain polar bonds, the only polar molecule is (a) CCl_4; (b) CO_2; (c) NH_3; (d) CH_4. _____ 9
10. A polar molecule is one in which (a) ions exist; (b) a region of positive charge and a region of negative charge exist; (c) only London forces exist; (d) no bonds are present. _____ 10

DIRECTIONS: Complete the following statements, forming accurate sentences.

11. According to VSEPR theory, the shape of an AB_2 molecule is _____. 11
12. According to VSEPR theory, the shape of an AB_3 molecule is _____. 12

DIRECTIONS: Write the answers to the following on the lines provided.

14. What can VSEPR theory be used to predict? _____

_____ 14

15. Write the structural formula for water, and describe its shape. _____

DIRECTIONS: Fill in the spaces below by checking either metallic solid or ionic solid, depending on which type of solid is associated with the property on the left.

Property	Metallic Solid	Ionic Solid
11. ductile		
12. brittle		
13. nonconductive		
14. malleable		
15. lustrous		